



**Generator Interconnection Feasibility Study
For
SCE&G V.C. Summer Nuclear #3
Version #2**

Prepared for:
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Generator Interconnection Feasibility Study for SCE&G V.C. Summer Nuclear #2

Generator Interconnection Feasibility Studies are intended to be preliminary studies to aid the requestor in determining if the application should be advanced to additional, more detailed and more costly studies or be withdrawn. These additional studies include the System Impact Study, Optional Upgrade Studies and the Facility Study. Interconnection Feasibility Studies do not determine the final facilities and costs of interconnecting the requested generator to the existing transmission system.

General Discussion

SCE&G Transmission Planning conducted an initial Generator Interconnection Feasibility Study for V.C. Summer #3 (report dated October 3, 2006) assuming SCE&G would own the entire power output of this unit. Subsequent to releasing the initial report, Transmission Planning was informed that Santee Cooper will own 45 % of the V.C. Summer #3 unit, also. This report presents the results of a study including this information.

The SCE&G Nuclear Group has applied for interconnection of a new 1375 MVA nuclear generator near the existing V.C. Summer site. This new generator would be the third nuclear unit at the V.C. Summer site. This new generator would be jointly owned by SCE&G and Santee Cooper, SCE&G would own 55% and Santee Cooper would own the remaining 45%. In this study SCE&G simulated Santee Cooper's portion of the generator being delivered to the Santee Cooper system.

This study assumes the V.C. Summer #2 unit is complete and all associated transmission as described in the Generator Interconnection Feasibility Study report for V.C. Summer #2 is in-place.

The format of the report is as follows:

- I. Generator Information (provided by the SCE&G Nuclear Group)
- II. Transmission Studies
 - A. Power Flow Analysis
 - B. Short Circuit Analysis
- III. Preliminary Recommendations
- IV. General Engineering Design
- V. Cost Estimates

I. Generator Information

The generator design consists of a single nuclear unit and one step-up transformer. The generator unit will have a maximum gross MVA output capacity of 1,375 MVA and a maximum net MW of 1,165 MW.

The generator design consists of the following information:

MVA – gross:	1375
MW – net:	1165
Power Factor:	between .90 and 1.05
Voltage:	22kV
Speed:	1800 rpm
X'd-sat.: 0.465 PU;	X''d-sat.: 0.325 PU
X2-sat.: 0.320 PU;	X0: 0.237 PU

II. Transmission Studies

A. Power Flow Analysis

For the proposed generator interconnection of the VC Summer #3 generator, Transmission Planning performed analyses of:

1. Base case conditions (no outages) simulating normal conditions
2. N-1 conditions simulating single facility outages of each transmission facility on the SCE&G system
3. Selected n-2 conditions simulating the loss of two facilities on the SCE&G transmission system

This study is based on future projected conditions on the SCE&G transmission system, simulating 2016 peak summer conditions and assumes that the following transmission improvements will be made to SCE&G's Columbia and Charleston area transmission system prior to 2016. These transmission improvements are currently scheduled and are needed for other system needs:

1. Upgrade Lyles-William Street 115kV line
2. Upgrade William Street-Coit 115kV line
3. Upgrade Lyles-Denny Terrace 115kV line #1 and #2
4. Add a 2nd Lake Murray 230/115kV auto transformer
5. Increase thermal rating on the Denny Terrace-Lyles 230kV line
6. Upgrade Canadys-Church Creek 230kV line
7. Add a Canadys-Pepperhill 230kV line (double circuit with Canady-Church Creek 230kV Upgrade)

As mentioned earlier, this study assumes the V.C. Summer #2 unit is complete and operating and the following associated transmission projects are complete and in-service:

1. VC Summer-Killian 230kV line
2. VC Summer-Lake Murray 230kV line
3. VC Summer (new)-VC Summer (existing) Bus #2 230kV line
4. VC Summer (new)-VC Summer (existing) Bus #3 230kV line
5. Upgrade the existing Denny Terrace-Lyles 230kV line
6. Upgrade the existing Parr-VC Summer #1 230kV line
7. Upgrade the existing Parr-VC Summer #2 230kV line
8. Add a 3rd 230/115kV 336 MVA auto transformer at Lake Murray
9. Add a 3rd 230/115kV 336 MVA auto transformer at Denny Terrace
10. Upgrade the existing Saluda-McMeekin 115kV line
11. Upgrade the existing Lake Murray-McMeekin 115kV line
12. Upgrade the existing Lake Murray-Saluda 115kV line

Additionally, this study assumes that the following proposed transmission modifications will be made by Santee Cooper to their transmission system as part of their interconnection to the V.C. Summer #2 generator. These transmission improvements were provided by Santee Cooper:

1. Add a VCS-Winnsboro 230kV line with 230/69kV transformers at Winnsboro.
2. Add a Winnsboro-Richburg 230kV line with 230/69kV transformers at Richburg.
3. Add a Richburg-Flat Creek 230kV line

Furthermore, this study assumes that the following proposed transmission modifications will be made by Santee Cooper to their transmission system as part of their interconnection to the V.C. Summer #3 generator. These transmission improvements were provided by Santee Cooper:

1. Add a VCS-Sandy Run 230kV line with a 230/115kV transformer at Sandy Run
2. Add a Sandy Run-Orangeburg 230kV line with a 230/115kV transformer at Orangeburg
3. Add an Orangeburg-St. George 230kV line with a 230/115kV transformer at St. George.
4. Add a St. George-Varnville 230kV line

Run #1 – Injection of the proposed 1,165 MW at the new VC Summer 230kV with no affiliated transmission improvements

For the initial analysis, an additional 1,165 MW is injected at the new VC Summer 230kV bus with no affiliated modifications to the SCE&G transmission system. With the existing VC Summer net generation of 966 MW, the Fairfield Pumped Storage net generation of 608 MW, the proposed VC Summer #2 net generation of 1,165 and the new proposed VC Summer #3 net generation of 1,165, the total net MW generation connected to the 230kV system in the vicinity of the VC Summer site is 3,904 MW.

Base Case Conditions

There are no overloaded facilities in the base case (no outages). However, several existing 230kV lines in the VC Summer area are loaded above 50% of their Normal Rating:

- The VCS#1 bus #1-Pineland 230kV line loads to 58% of its 475 MVA Normal Rating
- The VCS#1 bus #1-Denny Terrace 230kV line loads to 56% of its 475 MVA Normal Rating
- The VCS#1 bus #1-Blythewood (Santee Cooper) 230kV line loads to 77% of its 478 MVA Normal Rating
- The VCS#1 bus #3-Lake Murray 230kV line loads to 52% of its 704 MVA Normal Rating
- The VCS#1 bus #3-VCS New 230kV line loads to 53% of its 950 MVA Normal Rating
- The VCS#1 bus #2-VCS New 230kV line loads to 53% of its 950 MVA Normal Rating
- The Parr-Denny Terrace 230kV line loads to 64% of its 704 MVA Normal Rating
- The Parr-Bush River (Duke) 230kV line loads to 52% of its 456 MVA Normal Rating

- The Lake Murray-Edenwood 230kV line loads to 59% of its 475 MVA Normal Rating

N-1 Conditions

The n-1 analyses show the following overload conditions due to the additional generation:

Overloaded Facility	Rating (MVA)	Loading (%)	Contingency
Saluda-White Rock 115kV line	95	111	Parr-Bush River (Duke) 230kV line

Selected N-2 Conditions

The n-2 analyses show the following overload conditions due to the additional generation:

Overloaded Facility	Rating (MVA)	Loading (%)	Contingency(s)
Lake Murray 230/115kV auto transformer #1	336	110	Lake Murray 230/115kV auto transformer #2 and Lake Murray 230/115kV auto transformer #3
Lake Murray 230/115kV auto transformer #2	336	110	Lake Murray 230/115kV auto transformer #1 and Lake Murray 230/115kV auto transformer #3
Lake Murray 230/115kV auto transformer #3	336	110	Lake Murray 230/115kV auto transformer #1 and Lake Murray 230/115kV auto transformer #2
VC Summer #1 bus #3-VC Summer New 230kV line	1020	100-135	VC Summer #1 bus #2-VC Summer New 230kV line and various other Columbia Area 230 and 115kV lines
VC Summer #1 bus #2-VC Summer New 230kV line	1020	100-135	VC Summer #1 bus #3-VC Summer New 230kV line and various other Columbia Area 230 and 115kV lines
Saluda-Georgia Pacific 115kV line	95	108	Parr-Bush River (Duke) 230kV line and Saluda-White Rock 115kV line
Saluda-White Rock 115kV line	95	133	Parr-Bush River (Duke) 230kV line and Saluda-Georgia Pacific 115kV line
Saluda-White Rock 115kV line	95	114	Parr-Bush River (Duke) 230kV line and VC Summer-Pomaria (Santee) 230kV line
Saluda-White Rock 115kV line	95	121	Parr-Bush River (Duke) 230kV line and Parr-Newport (Duke) 230kV line
Saluda-White Rock 115kV line	95	117	Parr-Bush River (Duke) 230kV line and VC Summer-Blythewood (Santee) 230kV line
Saluda-White Rock 115kV line	95	115	Parr-Bush River (Duke) 230kV line and VC Summer-Ward 230kV line

Saluda-White Rock 115kV line	95	117	Parr-Bush River (Duke) 230kV line and Wateree-Sumter (Progress) 230kV line
Saluda-White Rock 115kV line	95	116	Parr-Bush River (Duke) 230kV line and VC Summer-Winnsboro (Santee) 230kV line
Saluda-White Rock 115kV line	95	111-114	Parr-Bush River (Duke) 230kV line and one of several other lines in the Columbia Area

The n-2 analyses show the following highly loaded conditions due to the additional generation:

Highly Loaded Facility	Rating (MVA)	Loading (%)	Contingency(s)
Lyles-Edenwood 230kV line	510	80	VC Summer #1 bus #3-Lake Murray 230kV line and VC Summer New-Lake Murray 230kV line
VC Summer #1 bus #1-Denny Terrace 230kV line	510	85	Parr-Denny Terrace 230kV line and VC Summer #1 bus #1-Pineland 230kV line
VC Summer #1 bus #1-Blythewood (Santee Cooper) 230kV line	550	91	Wateree-Sumter (Progress) 230kV line and VC Summer-Winnsboro (Santee Cooper) 230kV line
VC Summer #1 bus #1-Pineland 230kV line	510	89	Parr-Denny Terrace 230kV line and VC Summer new-Killian 230kV line
VC Summer #1 bus #3-Lake Murray 230kV line	755	90	Parr-Denny Terrace 230kV line and VC Summer New-Lake Murray 230kV line
VC Summer New-Lake Murray 230kV line	1020	92	VC Summer #1 bus #3-VC Summer New 230kV line and VC Summer #1 bus #2-VC Summer New 230kV line
Wateree-Sumter (Progress) 230kV line	500	85	Wateree-Orangeburg 230kV line and Wateree-Summerville 230kV line

Run #2 – Create new paths from VC Summer to Charleston Load Center

In Run #1, four of the six major 230kV lines from the VC Summer Area to the Columbia Load Center are highly loaded for an outage of two of the four remaining lines. Upgrades would be needed on at least two of the four lines to address these overloads or additional new 230kV lines from the VC Summer Area to the Columbia Load Center would be needed.

Also in Run #1, the two 230kV lines leaving the VC Summer New 230kV substation to the existing VC Summer Substation, each overload for the outage of the other. To

address this, we will evaluate adding a 3rd 230kV line from VC Summer New 230kV substation to the existing VC Summer Substation bus #1 with B1272 conductor.

We also have two major 230kV tie lines that are highly loaded. The 230kV lines are the Wateree-Sumter (Progress) 230kV line (a transmission tie with Progress Energy) and the VC Summer #1-Blythewood (Santee Cooper) 230kV line (a transmission tie with Santee Cooper). The high loading on these two lines shows that the generation is trying to leave the Columbia area or, in other words, the generation in the Columbia area needs another path to a major load center.

In Transmission Planning's 2016 system model, the Columbia area has a projected load of 2,110 MW. In that same year, including the VC Summer #3 1,165 MW generator, there is a total of 5,772 MW of generation located in the Columbia area with 3,793 MW owned by SCE&G and the remainder owned by Santee Cooper (their ownership portion of VC Summer #1, #2 and #3) and the Columbia Energy Center. Just in the VC Summer area, there is a total of 3,904 MW of generation with 2,534 MW belonging to SCE&G.

In Transmission Planning's 2016 system model, the Charleston area has a projected load of 1,960 MW. However, there is only 857 MW of SCE&G generation located in the Charleston area.

All of this information shows that there will be significant generation excess in the Columbia area while there is significant generation deficit in the Charleston area, as indicated in the table below.

Year 2016 Projected Load and Generation Levels

	Total Load (MW)	Total SCE&G Generation (MW)	Difference (MW)
Columbia Area	2,110	4,317	2,207 (excess)
Charleston Area	1,960	857	-1,103 (deficit)

The generation deficit in the Charleston area is of concern to Transmission Planning, especially when contingencies are considered. A large portion of the generation in the Charleston area is the AM Williams unit (615 MW). When this unit is outaged the remaining SCE&G generation in the Charleston area is 242 MW creating a generation deficit of **-1,718 MW** in the Charleston area. To address this concern, the following analysis will evaluate the effectiveness of new 230kV lines from VC Summer toward the Charleston Load Center.

Power flow simulations show two 230kV circuits will be required to carry an adequate portion of the 1,165 MW being studied away from the VC Summer Generation Site. Adding a total of two new 230kV circuits will carry approximately 300 MW out of the VC Summer area to the Charleston load center during normal conditions.

For Run #2, the following transmission modifications are made:

1. Establish a St George 230kV Switching Station with six line terminals. Fold in the existing Wateree-Summerville 230kV line and the existing Canadys-Santee 230kV line at St George.
2. Add a VC Summer New-St George 230kV line #1 and #2 (double circuit) with B1272 conductor

The additional 230 and 115kV overloaded facilities that were identified in Run #1 will be addressed, if needed, in subsequent runs.

Base Case Conditions

There are no overloaded facilities in the base case (no outages).

N-1 Conditions

Overloaded Facility	Rating (MVA)	Loading (%)	Contingency
Saluda-White Rock 115kV line	95	108	Parr-Bush River (Duke) 230kV line

Selected N-2 Conditions

The n-2 analyses show the following overload conditions due to the additional generation:

Overloaded Facility	Rating (MVA)	Loading (%)	Contingency(s)
Saluda-Georgia Pacific 115kV line	95	104	Parr-Bush River (Duke) 230kV line and Saluda-White Rock 115kV line
Saluda-White Rock 115kV line	95	128	Parr-Bush River (Duke) 230kV line and Saluda-Georgia Pacific 115kV line
Saluda-White Rock 115kV line	95	116	Parr-Bush River (Duke) 230kV line and Parr-Newport (Duke) 230kV line
Saluda-White Rock 115kV line	95	112	Parr-Bush River 230kV line and VC Summer #1 bus #1-Blythewood 230kV line
Saluda-White Rock 115kV line	95	113	Parr-Bush River 230kV line and VC Summer #1 bus #2-Ward 230kV line
Saluda-White Rock 115kV line	95	108-113	Parr-Bush River 230kV line and one of various other 230 and 115kV lines in the Cola area
Lake Murray 230/115kV auto transformer #1	336	106	Lake Murray 230/115kV auto transformer #2 and Lake Murray 230/115kV auto transformer #3
Lake Murray 230/115kV auto transformer #2	336	106	Lake Murray 230/115kV auto transformer #1 and Lake Murray 230/115kV auto transformer #3
Lake Murray 230/115kV auto transformer #3	336	106	Lake Murray 230/115kV auto transformer #1 and Lake Murray 230/115kV auto transformer #2

VC Summer #1 bus #3-VC Summer New 230kV line	1020	112	VC Summer #1 bus #2-VC Summer New 230kV line and VC Summer New-Lake Murray 230kV line
VC Summer #1 bus #2-VC Summer New 230kV line	1020	112	VC Summer #1 bus #3-VC Summer New 230kV line and VC Summer New-Lake Murray 230kV line

The n-2 analyses show the following highly loaded conditions due to the additional generation:

Highly Loaded Facility	Rating (MVA)	Loading (%)	Contingency(s)
St George-Canady 230kV line	377	87	AM Williams Generation and St George-Summerville 230kV line
St George-Summerville 230kV line	377	91	AM Williams Generation and Canady-Church Creek 230kV line
St George-Summerville 230kV line	377	92	AM Williams Generation and Canady-Pepperhill 230kV line or Canadys-St. George 230kV line
St George-Summerville 230kV line	377	85	Canadys-Pepperhill 230kV line and Canadys-Church Creek 230kV line
St George-Summerville 230kV line	377	87	AM Williams Generation and Canady-Williams 230kV line
VC Summer #1 bus #1-Blythewood (Santee Cooper) 230kV line	550	83	Wateree-Sumter (Progress) 230kV line and VC Summer-Winnsboro (Santee Cooper) 230kV line
VC Summer #1 bus #1-Pineland 230kV line	510	83	Parr-Denny Terrace 230kV line and VC Summer New-Killian 230kV line
VC Summer #1 bus #3-Lake Murray 230kV line	755	84	Parr-Denny Terrace 230kV line and VC Summer New-Lake Murray 230kV line

Run #3 - Correct Overloaded and Highly Loaded Facilities

In Run #2, the additional generation along with the transmission modifications made to accommodate the generation result in some overloaded and highly loaded lines in the St George and Charleston areas. Also, some Columbia facilities are still showing as overloaded. These will be addressed in this run.

For Run #3, the following transmission modifications are made:

1. Construct a VC Summer New-VC Summer #1 bus #1 230kV line with B1272 conductor
2. Upgrade the St. George-Summerville 230kV line to B1272

3. Upgrade the St. George-Canadys 230kV line to B1272
4. Upgrade the Saluda-White Rock 115kV line to 1272
5. Upgrade the Saluda-Georgia Pacific 115kV line to 1272

Base Case Conditions

There are no overloaded facilities in the base case (no outages).

N-1 Conditions

There are no overloaded facilities due to the additional generation.

Selected N-2 Conditions

The n-2 analyses show the Lake Murray 230/115kV autotransformers continue to overload for the loss of the other two autotransformers. This will be addressed by adding additional 230/115kV transformation in the Lexington area.

Because the VC Summer #3 generator, along with the VC Summer #1 and #2 units, will result in significant nuclear generation on the SCE&G system with electrical power outputs that is not expected to vary with changing load conditions, Transmission Planning is concerned about off-peak system conditions. During light load system conditions in 2016, the total amount of nuclear output on the SCE&G system can exceed the total amount of system load. As part of this study effort, light load, spring peak load and shoulder load (75% of peak) system conditions were reviewed. This review showed that several system facilities overload during contingency conditions at off-peak load conditions due to the expected unusual generation dispatch (all or mostly nuclear generation) and the fact that all this generation is located in one area. Transmission Planning will conduct a more thorough study of these conditions as part of the Generator Interconnection System Impact Study.

B. Short Circuit Analysis

An initial review of the effect of the increased fault current in the SCE&G area indicates that three 230kV breakers and eight 115kV breakers on the SCE&G transmission system may become overstressed with the addition of the VC Summer #3 generator and associated transmission improvements. These overstressed breakers would need to be replaced with higher capacity breakers.

The total short circuit contribution from the SCE&G Transmission System that will be seen at the VC Summer new Substation 230 kV bus is:

Z positive (p.u.)	X/R	Z negative (p.u.)	X/R	Z zero (p.u.)	X/R
0.00033+j0.00501	15.0	0.00034+j0.00501	14.9	0.00031+j0.00348	11.2

These values do not include the contribution of the VC Summer #3 generator. They do include the expanded SCE&G Transmission System with projected improvements at the time of interconnection and generation that is connected to the SCE&G Transmission System (including the proposed VC Summer #2 generator, the existing VC Summer #1 generator and the Fairfield Pumped Storage Units). The values are calculated on a 100 MVA base. A significant change is not expected in this equivalence for the next 10 to 15 years, unless additional generation is interconnected in the area.

III. Preliminary Recommendations

Proposed Transmission Improvements

The analyses performed in this study show that constructing two new 230kV lines from the proposed VC Summer #3 generator to the Charleston area load center, plus additional transmission improvements described below, are required to reliably transmit the SCE&G's ownership portion of the 1,165 MW of the proposed VC Summer #3 generator from the VC Summer area to the remainder of the SCE&G system.

The required transmission projects are:

1. Construct VC Summer-St George 230kV Double Circuit B1272 line (135 miles)
(Add 2 230kV terminals at VC Summer New)
(breaker-and-a-half design)
2. Construct VCS New-VCS#1, Bus #1
(add 230kV terminal at existing VC Summer Bus #1)
(breaker-and-a-half design)
3. Establish a St George 230kV Switching Station (breaker-and-a-half design)
(6 terminals - 9 breakers)
(Add land)
4. Fold-in the Canadys-Santee 230kV line at St George
5. Upgrade the Canadys-St George 230kV line to B1272
(Upgrade Canadys terminal)
6. Fold-in the Wateree-Summerville 230kV line at St George
7. Upgrade the St George to Summerville 230kV line to B1272
(Upgrade Summerville terminal)
8. Upgrade Saluda-Georgia Pacific 115kV Double Circuit line to 1272
(Upgrade Saluda terminal)

Add five (5) terminals (9 breakers) to the VC Summer New substation (breaker-and-a-half design).

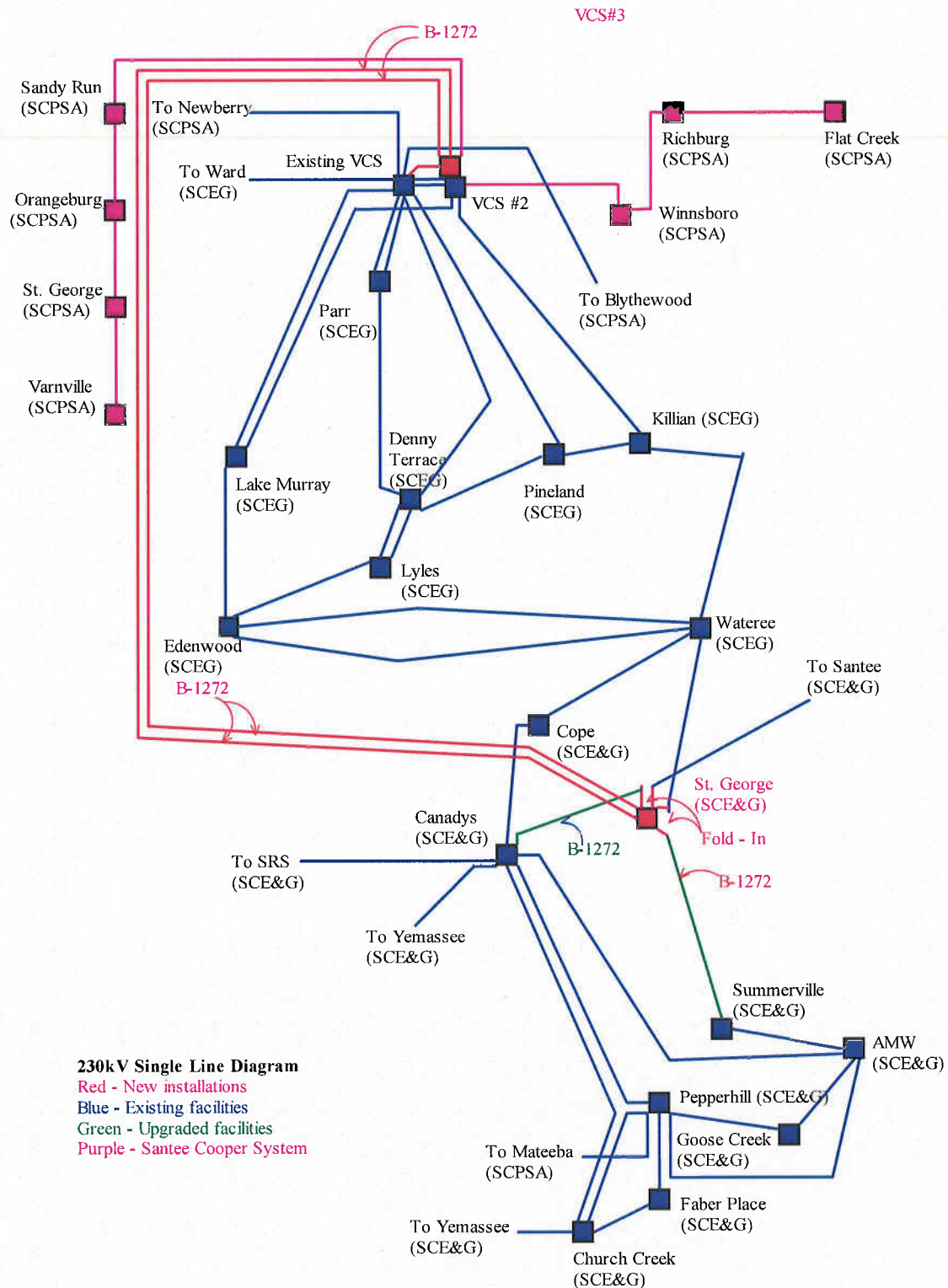
1. One - for VC Summer #3 generator step up transformer
2. One - for VC Summer #3 station service
3. One - for the new 230kV line to the existing VC Summer #1 230kV bus #1
4. Two - for the 2 new 230kV lines to St George

To resolve overstressed conditions of the breakers as described in the Short Circuit Analysis section, Transmission Planning recommends replacing the following breakers with higher interrupting capability breakers:

Location	Voltage	Breaker #
VC Summer	230	8822
VC Summer	230	8932
VC Summer	230	8902
Lyles	115	732
Edenwood	115	3052
Dunbar	115	1112
A.M. Williams	115	5712
St. George	115	5002
St. George	115	5022
St. George	115	5052
St. George	115	5082

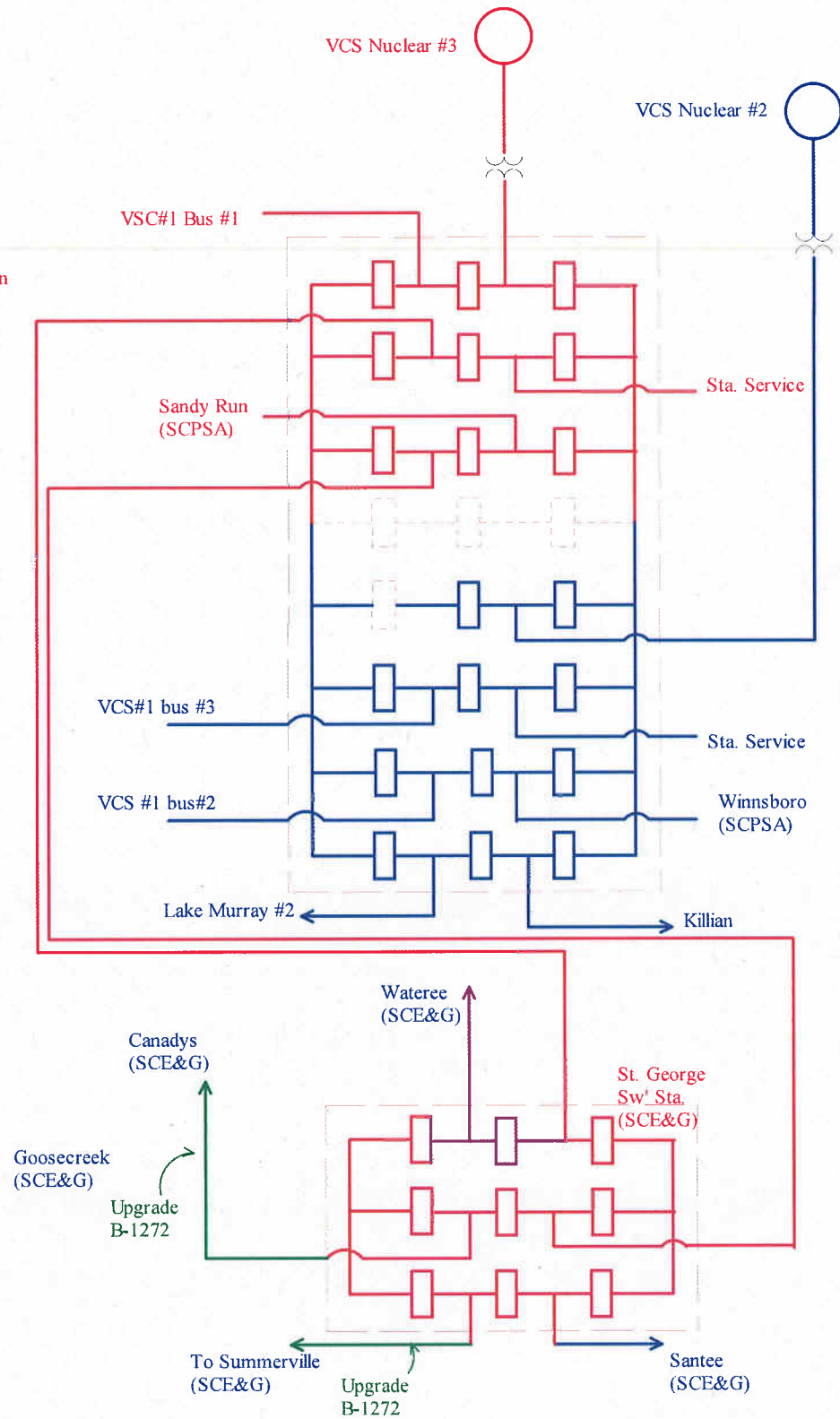
IV. General Engineering Design

Single Line Diagram



Substation Single Line

Blue - Existing system
Red - New Construction
Green - Upgrade



V. Cost Estimates

All cost estimates are in 2006 dollars.

1. Construct VC Summer New-St George 230kV Double Circuit B1272 line (135 miles)	\$153,950,000
2...Construct VCS New-VCS#1, Bus #1).....	\$600,000
(add 230kV terminal at existing VC Summer #1 Bus #1)	\$1,100,000
3. Construct St George 230kV Switching Station (Breaker-and-a-half design)	\$11,400,000
4. Fold-in the Canadys-Santee 230kV line at St George	\$1,100,000
5. Upgrade the Canadys-St George 230kV line to B1272	\$7,300,000
6. Fold-in the Wateree-Summerville 230kV line at St George	\$1,100,000
7. Upgrade the St George to Summerville 230kV line to B1272	\$15,300,000
8. Upgrade Saluda-Georgia Pacific 115kV Double Circuit line to 1272	\$11,900,000
Expand the 230kV generator substation at the VCS New site	\$12,000,000
Replace overstressed	
1. 230kV breakers - 3	\$600,000
2. 115kV breakers - 8	\$1,200,000
Total Cost Estimate	\$217,550,000